

In the illustrated embodiment, the group III-V device has been fully released from the substrate. As shown, there is a small gap between the top of the protuberance and the bottom of the group III-V device. Such a fully released device may represent a suspended or free-floating device which is not physically coupled with the substrate by a portion of the graded composition release layer. In such a case, the anchor 354 may help to anchor the suspended or free-floating group III-V device to the adjacent fixed left structure 342L to help prevent it from falling.

[0059] FIG. 3H shows an embodiment of coupling an embodiment of a receiving substrate 326 with the group III-V device of the workpiece object 310G of FIG. 3G. The receiving substrate may be physically and/or electrically coupled with the top surface of the group III-V device. The receiving substrate may represent any of various substrates known in the arts which are operable to lift off, peel off, extract, or otherwise receive the group III-V device from the substrate 311. In some embodiments, a flexible and puncture proof receiving substrate may optionally be used, although this is not required.

[0060] In some embodiments, the receiving substrate may represent a circuit. For example, in various embodiments, the receiving substrate may represent a rigid printed circuit board, a flexible printed circuit board, a flexible circuit, an organic chip carrier, an organic circuit board, a ceramic chip carrier, or the like. The receiving substrate may have interconnects 360 including electrical contacts. The interconnects may represent patterned electrically conductive material insulated by surrounding dielectric material. In some embodiments, coupling the receiving substrate with the group III-V device may include electrically coupling the electrical contacts of the receiving substrate with corresponding electrical contacts of the group III-V device. The receiving substrate may have its electrical contacts formed into mating or matching aligned positions with the electrical contacts of the devices to be lifted off. The side of the workpiece object 310G having the upper electrical contacts may represent a receiving substrate contact side or a metallization side.

[0061] In some embodiments, reflowed solder bumps 362 may be used to physically and electrically couple the electrical contacts of the receiving substrate 326 with corresponding upper electrical contacts 338U of the group III-V device 316H. The reflowed solder bumps represent an example of coupling members. The solder bumps 362 may initially be included on either the electrical contacts of the receiving substrate or the upper electrical contacts of the group III-V device. The receiving substrate and the group III-V device may be aligned or positioned so that the electrical contacts are aligned relative to one another with the solder bumps disposed between them. The receiving substrate and the group III-V device may be brought together so that the corresponding electrical contacts are physically and electrically coupled through the intervening solder bumps. Either one or both of the substrates may be moved relative to the other. In the illustration, the electrical contacts of the receiving substrate are positioned above the solder humps. The solder bumps may be melted or reflowed and then cooled and solidified to physically and electrically couple the receiving substrate with the group III-V device. Alternatively, instead of solder humps, other portions of solder, other metal bumps, other metal particles, other reflowable metals, other reflowable conductive materials, conductive adhesives, or the like, may

be used as the coupling members to couple the electrical contacts and/or the receiving substrate with the group III-V device.

[0062] In the illustrated embodiment, electrical contacts are used to couple the receiving substrate with the group III-V device. In other embodiments, it is not required that the receiving substrate be coupled with the group III-V device through such electrical contacts. For example, in other embodiments, glue, sticky material, tacky material, adhesive material, or the like, may be disposed between the contact surfaces of the receiving substrate and the group III-V device to couple them. For example, the receiving substrate may have an adhesive backing similar to a tape to physically but not electrically couple with the group III-V device. In still other embodiments, a combination of such solder humps or other electrical coupling members and an adhesive material may optionally be used to provide even greater couplings.

[0063] FIG. 3I shows an embodiment of separating 324 the receiving substrate 326 having the group III-V device 316I coupled therewith from the substrate 311. In various aspects, the receiving substrate may be moved relative to the substrate, the substrate may be moved relative to the receiving substrate, or both the receiving substrate and the substrate may be moved relative to one another. The physical coupling of the receiving substrate with the group III-V device may be stronger than the physical coupling of the substantially released group III-V device with the substrate. As a result, the group III-V device may remain coupled with the receiving substrate, and the group III-V device may fully release (if it is not already) and separate from the substrate. The separation force applied may cause any remaining portion of the graded composition release layer coupling the group III-V device to the substrate to sever or break. The separation force applied may also cause any present anchors to sever or break. For example, the patterned photoresist anchor 354 may sever or break as shown by broken photoresist anchor 354*. Note that it is also possible for the patterned photoresist anchor to merely become detached from one of the left structure and the group III-V device instead of actually being ripped apart or severed. Subsequently, any remaining photoresist may optionally be removed by stripping, dissolved in a suitable solvent (e.g., acetone, isopropyl alcohol, etc.), or otherwise removed. Also, the bridge anchor 356 may sever or break as shown by broken bridge 356*.

[0064] It has been previously mentioned that the etch has been performed until the group III-V device and/or the other semiconductor devices have been “substantially released.” As used herein, the term “substantially released” encompasses the semiconductor device being either fully released and/or released enough that the semiconductor device can be separated from the substrate using less force than would be required to break the coupling between the receiving substrate and the semiconductor device. For example, any remaining coupling of the semiconductor device with the substrate through a remaining contact with a protuberance and/or through any anchors may be less than the coupling strength of the mechanism used to couple the receiving substrate with the semiconductor device (e.g., reflowed solder bonds, adhesive, etc.).

[0065] In the illustrated embodiment, separating the group III-V device from the substrate also involves separating the group III-V device from the protuberance 320 and/or non-flat surface 321, although this is not required. In some embodiments, this may involve lifting the group III-V device from off